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# Shaping Air Mobility Forces for Future Relevance

Robert C. Owen



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## About the Author

Robert C. Owen is a professor in the Department of Aeronautical Science at Embry-Riddle Aeronautical University, Daytona Beach Campus. In this position, he teaches courses in manned and unmanned aviation operations, law, and history and conducts research in national defense policy issues. Owen joined the Embry-Riddle faculty in 2002, following a 28-year career with the United States Air Force. His military career included a mix of operational, staff, and advanced education assignments. He is both an Air Force command pilot and a commercial pilot and has logged over 4,500 hours of flight time in around 25 different aircraft. Professor Owen also served on the Headquarters Air Force staff and the Headquarters Air Mobility Command staff as a doctrinalist and strategic planner. His academic assignments included tours as an assistant professor of history at the US Air Force Academy, dean of the USAF's School of Advanced Airpower Studies (now the School of Advanced Air and Space Studies), the service's graduate school for strategic planners, and as chair of the Aeronautical Science Department at Embry-Riddle. In addition to numerous articles and monographs, his book publications include the *Chronology* volume of the *Gulf War Air Power Survey* (1995), *Deliberate Force: A Case Study in Effective Air Campaigning* (2000), and *Air Mobility: A Brief History of the American Experience* (2013).



## **Introduction**

This report asks whether the national air mobility system (NAMS) of the United States will or will not be able to accomplish its full spread of mission responsibilities in an uncertain future fraught with emerging challenges and threats. More specifically, this report will examine operational, institutional, doctrinal, and technological trends shaping a useful answer to that question. That answer will recognize the unequalled readiness of the NAMS for future wars and conflicts while also identifying some of its more troubling shortfalls in specific task areas. In the end, this study will identify opportunities to mitigate those shortfalls in the near term and without breaking the defense budget, and it will propose some initial steps along a path to further reducing or even eliminating them over the longer term. Accordingly, this report proceeds in four sections. It begins with a brief discussion of some of the more influential and enduring contextual elements of air mobility policy—namely structure, mission, and technology. It describes some emerging challenges to the nation's ability to conduct global air mobility operations effectively. It then discusses shortfalls in the current program of record fleet's ability to address those challenges and ends by identifying near- and longer-term opportunities to make things better in a “challenging fiscal environment.”<sup>1</sup>

## **Context: The National Air Mobility System**




Enduring contextual elements of the NAMS will influence the success of any future decisions regarding its organization, fleet structure, doctrines, and so on. Its roots go back almost exactly a century, when the US Army used aircraft to fly dispatches and mail in support of the 1916 Punitive Expedition into Mexico. The modern system—an interconnected complex of airlift and air refueling operating forces and a global infrastructure of command and support elements—has been in existence since the late 1940s. Though the NAMS has undergone refinements in the details of its institutional composition and specific mission requirements, its foundational structure, mission responsibilities, and technological constraints have remained (and likely will remain) stable. Any efforts to understand and shape the future of the air mobility system, therefore, must begin with an appreciation of those enduring elements of the NAMS and their relevance to planning and operations.

## **Structure**

The NAMS consists of four components. The Civil Reserve Air Fleet (CRAF) is the largest component in terms of airlift capacity, currently provid-

ing about half of the 54 million ton-miles per day (MTMD) lift capacity of the NAMS.<sup>2</sup> As of January 2016, 20 airlines were contributing 453 modern passenger and cargo aircraft to the CRAF, 415 of which were large and mostly wide-body aircraft suited to international operations.<sup>3</sup> The military components of the NAMS are twofold and contain the active duty component and the air reserve component (ARC, which consists of the Air National Guard and the Air Force Reserve). Most ARC and active forces are assigned to units aligned with only one component, but some associate units share common pools of aircraft and equipment. In 2016 the combined aircraft strengths of the active and ARC components included 52 C-5 and 223 C-17 long-range transports, about 330 (decreasing toward 300) C-130 theater transports, and about 400 KC-135 and 59 KC-10 air refueling aircraft with secondary air transport capabilities. The so-called air mobility enterprise comprises the fourth component of the NAMS. It consists of the whole global network of permanent and temporary bases, mobile support units, command-and-control centers, coordination and liaison elements, planning staffs, education and training institutions, communications systems, maintenance depots, and a host of other institutions needed to keep the NAMS running effectively and able to conduct planned and unexpected global operations.<sup>4</sup>

**Table 1. The national air mobility system**

<i>Component</i>	<i>Content of component</i>	<i>Example of component content</i>
Civil Reserve Air Fleet	450+ passenger and cargo aircraft	
Military: Active component Air reserve component (Air National Guard and Air Reserve)	575+ transports 450+ tankers	
Air mobility enterprise	People Bases Command and control, etc.	

The command relationships applied to these forces are consistent with US joint doctrines. The Air Force, Air National Guard, and Air Force components of the geographic combatant commands—such as Air Forces Europe, Air Forces Africa, and Pacific Air Forces—perform the service functions of

training, organizing, equipping, and sustaining mobility forces. Through standing documents and amending orders in times of crisis, the secretary of defense assigns all operational air mobility units to combatant commands. Of these commands, the US Transportation Command controls most long-range or global air mobility forces and provides general, or common user, air mobility and sustainment support to the entire defense community. US geographic commands, such as the European, Africa, and Pacific Command, receive theater forces for support of their own operations. Despite their theater appellation, these geographically assigned air mobility forces can consist of any aircraft type, though they tend to be C-130s, C-17s, and KC-135s. Combatant commanders normally assign operational command of their air mobility forces to their joint force air component commanders, who control them through the air operations centers of numbered air forces, most importantly Ninth Air Force for Central Command, Eleventh Air Force for Pacific Command, Seventeenth Air Force for European and Africa Commands, and Eighteenth Air Force for Transportation Command. Put succinctly, the services prepare forces for assignment to combatant commands, which control their operations in peace and war.

For anyone concerned with the future of air mobility, these command relationships are important because they lay out the geography of how studies are done and force structure plans are made. In short, organizations in the combatant chain of command study operations and set general capacity and capability requirements for air mobility forces. Service elements, mainly headquarters USAF and Air Mobility Command (AMC), develop management plans for air mobility forces, including those regarding personnel preparation and support, capabilities and composition of the fleet, aircraft acquisition programs, and doctrines. The combatant and service communities do collaborate formally and informally on all studies, but their general responsibilities remain distinct. So discussions of current and future requirements, such as the *Mobility Capabilities and Requirements Study-2016*, impinge on the realm of the office of the secretary of defense and combatant responsibilities, while capabilities studies and specific force-structure plans generally are service products. When a service element such as AMC discusses requirements, it usually does so in the context of tactical operations, as in the need for specific radios or missile decoy systems, in reflection of existing combatant requirements, or in close coordination with the combatant chain if considering operational and strategic issues.

Also important to shaping air mobility policy is that all of the military services operate “organic” air mobility forces that are not part of the NAMS but, nevertheless, complement and extend its capabilities. The Army has hundreds

of UH-60 and CH-47 helicopters assigned to battalions within its aviation brigade combat teams (BCT). The Marine Corps also operates squadrons of CH-46, CH-53E, CH-53K, and MV-22 lift helicopters as well as five tanker-transport squadrons equipped with a total of about 60 KC-130J aircraft. The Air Force Special Operations Command fields a modest fleet of MC-130 transport and tanker aircraft equipped to support special land and air operations deep inside enemy threat areas. The Navy also operates transport aircraft to link shore bases and to deliver supplies and passengers to ships at sea. Importantly, the rotary-wing aircraft in the Army and Marine fleets have very limited payload-over-distance capabilities, or range/payload curves, as compared to Air Force aircraft. When operated in large numbers, consequently, they can move a lot but typically only out to distances of 100 miles or less from their main bases. Still, from a general perspective, these organic assets provide specialized capabilities that extend the tactical reach and maneuver of American air mobility forces from the aerial ports of debarkation utilized by NAMS components to forward landing and airdrop zones and shipborne landing decks. (See the appendix for an illustration of payload and range performance of mobility aircraft.)



**Figure 1. Chinook and Osprey aircraft.** *Left:* A CH-47F Chinook conducts a mission in northern Afghanistan; *right:* An MV-22 Osprey tilt-rotor aircraft lands on a Japanese navy helicopter destroyer.

## Mission

The air mobility spread of missions is more complicated than it might at first appear. Air mobility sloganeers have encapsulated its mission as moving “anything, anytime, anywhere” or as a “fort-to-foxhole” continuity of service. In less exuberant language the Air Mobility Command today seeks to “provide global air mobility . . . right effects, right place, right time.”<sup>5</sup> The caveat to

all this enthusiasm is the multiplicity of meanings that anything, anytime, and anywhere can have in air mobility planning and operations. The *things* that air mobility forces and complementing aviation arms must move range from battle tanks, special operations assault craft, and deep submergence submarine rescue vehicles at the high end of size and weight to endless lists of lighter items, ranging down to boxes of bandages and candy bars. *Time* has an infinitely flexible meaning in this realm; some administrative cargos can move more or less routinely through the airlift system, while air and ground combat units might need to move over global distances in matters of a few days or even hours. Finally, *where* includes the widely varying distances over which tanker and transport aircraft must fly, the nature of the bases from which they must operate, the terminal points into which they must deliver their payloads, and the atmospheric conditions under which they must operate.

Equally important to understanding the air mobility challenge are the widely variable natures of the terminal points—airfields, airstrips, landing zones, and so on—from which transports and tankers can operate and into which airlift aircraft must deliver their loads. The landing terminal points useable by airlift aircraft also are critically important to the challenge of delivering ground units to their destinations with their full complements of protected maneuver, firepower, and support vehicles ready for immediate combat operations. Delivering core vehicles and their expanded armor kits separately at forward fields, for example, imposes delay and risk as Soldiers and Marines scramble to put them together. The summary implications of these variations are that the present and future air mobility missions will manifest endless combinations of payload, time constraints, and locations of operations and delivery.

### **Terminal Points: An Examination**

A slight digression will be useful here to clarify a number of terms regarding air mobility terminal points. In the absence of any universal taxonomy of airfields or terminal points, this paper organizes them into operationally significant tiers. Tier 1 terminals are “global-class” airports and air bases—capable of supporting sustained operations by large and fully loaded civil and combat aircraft under nearly all reasonable density altitude conditions.<sup>6</sup> They generally are characterized by wide runways of around 8,000–10,000+ feet in length and pavement and subgrade combinations several feet thick. If they have substantial parking areas (it takes about an acre of surface to park a large transport or tanker aircraft), these are the terminals that air mobility planners prefer to use as aerial ports of embarkation and debarkation and as air refuel-

ing operating bases in forward areas. Tier 2 terminals are smaller air bases, civilian regional airfields, and perhaps national airports in less-developed countries. Generally, Tier 2 runways can accommodate medium-sized transport category and fighter-type aircraft. Typically they are 5,000–8,000 feet long, usually long enough to allow takeoff and landing operations of appropriate aircraft at likely density altitudes. Some Tier 2 terminals may have large parking areas, but civilian regional airfields in the less developed parts of the world are likely to have parking for only a few medium-size aircraft, if any. Tier 3 terminal points are unpaved air strips or even open fields suitable for sustained operations by medium-weight air transports, such as C-130Js and A400Ms, and perhaps episodic use by heavier aircraft, such as the C-17. For this paper, Tier 4 terminals are points or restricted areas of hard-surfaced or unsurfaced terrain suitable for operations by vertical takeoff and landing (VTOL) aircraft only. Forward arming and refueling points (FARP) comprise a subgroup overlapping the Tier 3 and 4 terminal categories. FARPs are temporary facilities organized to provide fuel and ammunition necessary for the employment of air units in combat.<sup>7</sup> Depending on the types of aircraft supported and the sources of their sustainment supplies, FARPs may be Tier 3 airfields, including highway strips, or Tier 4 terminal points supporting VTOL aircraft. Any airfield may be austere if it is not equipped with support infrastructure, such as refueling systems, service buildings, billeting facilities, and so on.



**Figure 2. Tier 2 and Tier 3 airfields.** *Left:* This characteristic Tier 2 airfield consists of a mile-long runway of medium strength with limited taxi and parking facilities. (Photograph courtesy of Ashland Regional Airport, 27 March 2016, <http://www.ashlandregionalairport.com/default.htm>); *right:* This characteristic Tier 3 airfield with a surface of compressed laterite and clay would have a California bearing ratio of 50 to 80 and could handle hundreds of passes by C-130s and A400Ms before requiring repairs.



Understanding airfields in tiers helps in evaluating actual and conceptual mission requirements for air mobility planning. For example, as repurposed civil airliners, fully loaded Air Force KC-10, KC-135, and future KC-46 aircraft generally operate from Tier 1 runways. These aircraft can operate from longer Tier 2 runways but usually with reduced fuel loads and, consequently, limitations on their abilities to support combat operations. Such operations may also be restricted by the scarcity of suitable parking pads for tanker aircraft at many Tier 2 regional airports and military bases. Thus, air combat plans and concepts predicated on receiving robust air refueling support may be challenged by the impossibility of stationing tankers near the combat zone or in the numbers required. Similarly, the Air Force's largest air transports, C-5s and C-17s, can carry their maximum payloads into Tier 1 airports and air bases. But if those bases are damaged or under threat of damage by enemy attacks, commanders may wish to push air transport operations onto nearby Tier 2 or even Tier 3 airstrips.

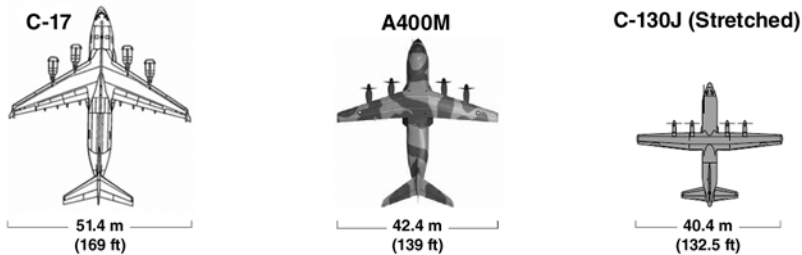
As with tanker operations, pushing transports out to less-developed airfields or even to the unpaved areas of main bases can sharply crimp their utility. Indeed, one recent Africa Command analysis indicated that all of sub-Saharan Africa had only about 16 airfields able to accommodate a handful of C-17s; consequently, these airfields were serving as hubs for C-130 operations to destinations as much as 1,000 miles away.<sup>8</sup> Finally, when Army planners ponder the value of “surprise through maneuver across strategic distances . . . [with] the mobility, protection, and firepower necessary to strike the enemy from unexpected directions,” they are wanting something the Air Force cannot do—transport of mechanized ground units across long distances and delivery precisely into less-developed Tier 2 or even Tier 3 terminal points at or within tactically useful distances from their points of need/employment (PON/E).<sup>9</sup>

## **Technology**

Terminal considerations continue to shape the design of civilian and military transport aircraft. In their manipulations of the aircraft design calculus of capacity, speed, range, maneuverability, and airfield requirements, transport aircraft designers have handled airfield requirements differently for commercial and military transports. Focused on profitability, the designers of airliners tend to emphasize seat-mile productivity on the presumption that airport infrastructures can be modified to handle whatever aircraft they produce. Historically this has been a safe presumption since airport operators generally have found ways to expand the facilities of existing fields or to create alto-

gether new airports to handle the demands of succeeding generations of airliners. So all successful commercial jet airliners since the 1960s have been of a type featuring wings swept back about 35–37° almost always mounted at the bottoms of long, tubular fuselages optimized for passenger carriage and landing gear assemblies designed for operation on hard-surfaced runways.

In contrast, the designers of military transports have emphasized throughput of military-type cargos at whatever airfields might be available during contingencies. Range and payload remain important considerations, of course, so military transports designs tend to reflect careful balances of airfield flexibility (the number of fields into which an aircraft can operate) and range/payload performance. Consequently, military transports usually feature high-mounted wings and strong landing gear assemblies permitting at least some ability to operate on unpaved surfaces. Aircraft intended to cross intercontinental distances usually have wings swept back about 25° to optimize their range/payload and airfield flexibility characteristics. Aircraft intended for operations into Tier 3 airfields generally are equipped with less swept or even straight wings to minimize their landing and takeoff rolls while retaining acceptable range/payload performance.



**Figure 3. Left to right: Planforms of C-17, A400M, and C-130J.** Each aircraft balances speed, range, payload, and runway requirements through different combinations of aerodynamic features and power. (Reproduced by permission from Airbus.)

Probably the most important implication for mobility planners is that the air mobility fleet consists of several broad aircraft types. CRAF air carriers overwhelmingly bring airliners to the fleet. The military components generally bring a bifurcated fleet composed of aircraft designs that trade off airfield flexibility for range and payload and designs emphasizing airfield flexibility at the expense of range and payload. This has been the model of the airlift fleet since the 1960s, a model dominated by C-141s, C-5s, and C-17s in the inter-

continental fleet segment and C-123s and C-130s in the theater fleet. At times, the Air Force fleet has included a class of smaller assault transports capable of conducting short takeoff and landing operations (STOL) onto unpaved and rougher-than-typical runways shorter than 1,000 feet. These STOL/rough-field (STOL/RF) aircraft have included Chase/Fairchild C-122s and C-125s appearing in the late 1940s and De Havilland of Canada C-7 aircraft appearing in the late 1950s. The Air Force considered larger STOL/RF designs—such as the Breguet 941, Ling-Temco-Vought XC-142, and De Havilland of Canada C-8—but largely abandoned this class of aircraft after the Vietnam War. Finally, the Air Force developed two replacements for the C-130 in the mid-1970s, the Boeing YC-14 and McDonnell-Douglas YC-15. These successful designs promised to give the Air Force an ability to deliver medium and heavyweight armored units into airfields equivalent to those required by the significantly smaller C-130. But the Defense Department abandoned these advanced medium STOL transports in 1979 in favor of developing the C-17. This multifaceted story of air transport aircraft design reflects the complexity of the mission and suggests the likelihood that tailoring the fleet to cover it all will not get easier or simpler in the future.



**Figure 4. XC-142A and C-7.** *left:* XC-142A being tested by NASA in 1969. This aircraft could take off and land vertically or on airstrips just a few hundred feet long with heavier loads. (Photograph courtesy of NASA, [https://crgis.ndc.nasa.gov/historic/LTV\\_XC-142A](https://crgis.ndc.nasa.gov/historic/LTV_XC-142A)); *right:* C-7 Caribou operating from a Tier 3 airstrip during the Vietnam War.

The Air Force's episodic quests for larger aircraft capable of operating into Tier 3 and even Tier 4 airfields reflect another enduring operational conundrum for force-structure planners—the disconnect in cargo capacity and takeoff and landing performance between global and theater transports. At the moment, combinations of CRAF and intercontinental military aircraft can deliver robust flows of forces and supplies into Tier 1 airports. As outsize transports, C-5s and C-17s can carry virtually any item of combat or support

equipment required by Army BCTs or air combat units. Large military transports also can utilize Tier 2 airfields, though their throughputs will be limited by the lengths and strengths of their runways and number of parking spots available. Otherwise, C-130s are the only aircraft available to move forces and supplies forward from Tier 1 to smaller Tier 2 and Tier 3 terminal points. As oversize transports, C-130s have the lifting capacity and internal cargo dimensions to carry light vehicles and some smaller or less-protected versions of medium-weight combat vehicles, such as Strykers, but nothing larger or heavier.<sup>10</sup>

This global-theater cargo capacity disconnect presents ground commanders with difficult tactical choices and sometimes dangerous operational risks. When deploying by air, for example, ground combat and support units equipped with or supported by outsize equipment (as most are) either must debark at Tier 1 airports and make potentially long road marches to their objectives or move what they can forward on C-130s and then wait for their heavier elements to catch up. Airdrop deliveries of some heavy equipment can speed up the advances of such units. However, key items such as self-propelled howitzers, counter-artillery radar systems, and multiple launch rocket systems cannot be airdropped. If consequently forced to make long road marches or divide their forces, ground units can lose their maneuver velocity and element of surprise, thereby being exposed to piecemeal attrition and seeing their lines of communications interdicted by the attacks of alerted enemies.

The global-theater capacity disconnect also can undermine the hitting power and sustainability of forward-deployed air combat forces. Forward airfields often will not have runways suitable for C-5 and C-17 operations, or if they do, their runways may be damaged or under imminent threat of damage from enemy strikes. In such cases, C-130s will be the primary sources of aerial resupply. C-130s are capable aircraft, but their inability to transport oversize cargo could restrict the kinds of support equipment available to forward combat units and the rate of resupply they can receive. In other words, the global-theater disconnect is an airpower as well as a land-power issue.

## **Emerging Challenges**

The future promises a perfect storm of declining American air mobility capabilities in the face of growing demands. The mobility fleet is aging, with large portions of it qualifying as antiques. Its rate of recapitalization, particularly in the air refueling fleet, is not likely to keep up with the age out of its oldest aircraft. Meanwhile, the demands placed on it are increasing as a consequence of numerous and well-developed trends in American security af-

fairs. These trends include declining absolute and relative American military power, withdrawing of the bulk of US land forces into the homeland, evolving Army and Air Force operational concepts, multiplying and intensifying global cultural conflicts, and the proliferating of enemies able to strike throughout the depth of American military capabilities. Given their relevance to understanding the risks facing air mobility forces and the combatant commands they support, the most significant trends are expanded on in this section.



**Figure 5. C-130 (foreground) parked next to C-5.** A single photo illustrates the global-theater air cargo compatibility gap.

### **Declining Strength**

The elephant in the room of American defense affairs is the decline of its military forces in absolute terms relative to the challenges they face. In the words of the chairman of the Senate Armed Services Committee, this is happening “at a time when we face a complex array of challenges not seen since the end of World War II.”<sup>11</sup> Sen. John McCain’s comments were prompted by release of a Heritage Foundation report, *Index of U.S. Military Strength*, which rated the aggregate ability of US military forces as “marginal and trending toward weak” in their ability to defend the country in the face of “aggressive” threats of “gathering strength” in every populated region of the world.<sup>12</sup> By the time the Heritage Foundation made its report, the secretary of defense had already warned that “our loss of depth across the force could reduce our ability to intimidate opponents . . . [who having] become accustomed to our presence could begin to act differently, often in harmful ways . . . [and] the situation . . . will worsen over the next 3 to 4 years.”<sup>13</sup> The chairman of the Joint Chiefs of Staff expressed the same concerns in *The National Military Strategy of the United States*, stating that “today’s global security environment is the most unpredictable I have seen. . . . [G]lobal disorder has significantly increased while some of our comparative military advantage has begun to

erode. We now face multiple, simultaneous security challenges . . . [and] future conflicts will come more rapidly, last longer, and take place on a much more technically challenging battlefield.”<sup>14</sup> Finally, in early 2016, the Air Force chief of staff considered the demands of a major war in Europe or in the Pacific and said simply, “We’re not very ready for that.”<sup>15</sup> The consistency of these authoritative evaluations makes clear that, from the perspective of general air mobility planning, the future security environment will be characterized by a smaller American defense establishment concentrated in the homeland, attempting to confront a widening and strengthening array of simultaneous threats spread across the globe.

### **Disaggregation**

Of similar import to mobility planners is the trend toward operational concepts that emphasize “adaptive basing” or other forms of agile disaggregation (or dispersal). *Disaggregation* in this case refers to the division of operational units into geographically dispersed subunits conducting operations coordinated in time and space. These subunits are agile if they are able to shift their operating bases or locations quickly and unpredictably. The Defense Department is committed to agile disaggregation to improve the “resilience of air, naval, ground, space, and missile-defense capabilities, even in the face of large-scale, coordinated attacks . . . and allow them to sustain high-tempo operations.”<sup>16</sup>

Accordingly, all US military services are developing doctrines and improving their capabilities in this style of operations. The Air Force has been experimenting for several years with deployments of small teams of fighters and C-17 transports to austere airfields to conduct operations for a few hours and then move on before enemies detect and launch effective strikes against them.<sup>17</sup> A recent study examined the agile disaggregation of air refueling forces at austere airfields within enemy long-range weapon engagement zones.<sup>18</sup> Similarly, having highlighted “the need to conduct dispersed operations with smaller, task-organized forces,” the Marines are refining their ability to operate fixed-wing fighter aircraft from dispersed expeditionary bases and forward arming and refueling points (FARPs) located at small airfields, highway strips, and other suitable locations.<sup>19</sup> On its part, the Army sees dispersed operations as essential in high-threat environments to “evade enemy attacks, deceive the enemy, and achieve surprise . . . and seize upon fleeting opportunities.”<sup>20</sup>



**Figure 6. Two approaches to disaggregating combat air basing.** *Left:* IAF Mirage 2000 landing on an improvised highway strip in India (Indian Air Force photo); *right:* A prepared autobahn strip with parking areas in Germany, circa 1978. The autobahn strip has the advantage of being able to accommodate air transport aircraft as well.

For mobility planners, of course, the salient implications of disaggregated combat operations are disaggregated air mobility operations. Air mobility forces in the future likely will employ agile and disaggregated basing themselves, while attempting to satisfy the increased aerial and ground refueling requirements of air forces and the expanded dependence of disaggregated ground forces on airlift for maneuver and sustainment support. In many foreseeable situations, military logisticians never will be able to establish surface lines of communication to these disaggregated air and ground units. Rising to such demands will be challenging but necessary to air mobility forces, given recognition by national leaders that “the ability to quickly aggregate and disaggregate forces anywhere in the world is the essence of global agility.”<sup>21</sup>

Among the services, the Army’s specific demands for air transportation are likely to increase the most in coming years. Importantly, this increase will not be driven by growth in the weights of Army combat units or its support echelons and logistical demands. While Army leaders are moving to equip infantry BCTs with more capable and inescapably heavier mobile, protected fire-power vehicles and to develop newer and potentially heavier classes of armored combat vehicles, they also are pushing numerous initiatives that will lighten field units.<sup>22</sup> These initiatives include reducing vehicle fuel demands, improving the efficiency of power generation and use, making supply chains more efficient, and so on.<sup>23</sup> Rather, the most important driver of increasing Army airlift needs will be more frequent and global air movements of its light, medium, and heavy BCTs and their support elements. Historically, light airborne and light infantry forces only deployed independently in low-intensity

conflicts involving relatively weak enemies. They usually deployed into high-intensity combat situations only in conjunction with heavy forces in place already or due to arrive in support within a few days. But in fast-breaking conflicts and crises in the future, joint commanders may project light forces by air over thousands of miles and well ahead of the possible arrivals of heavier units via ships or overland marches. Nevertheless, if strong enemy threats are present, such movements of light forces will need to be accompanied by air transport of some medium or heavy units, either as integrated elements of task-organized light units or as independent battalions and brigades.

At the high end of its emerging requirements, the Army wants the support of air mobility forces able to lift at least medium-weight armored equipment, such as fully armored Strykers and self-propelled artillery, over strategic distances and to deliver them very near or precisely at their PON/Es. The most ambitious variation of this concept is mounted vertical maneuver (MVM), “the maneuver and vertical insertion of medium weight armored forces into areas in close proximity to their battlefield objectives without the need for fixed airports, airfields, or prepared airheads.”<sup>24</sup> In pursuit of MVM, Army leaders have long expressed a hope that the Defense Department will authorize development of a vertical takeoff and landing aircraft capable of carrying medium-armored vehicles at least as heavy as 30–32 ton M-3 Bradleys.<sup>25</sup> Over the last several decades, the Army and the Air Force have collaborated in several assessments of the operational value and mobility of aircraft required to support such precision-delivery-over-strategic-distances operations. But as yet, the services have not settled upon a definitive design concept, nor has the Defense Department authorized funding for developing the concept or necessary aircraft.

### **Strong Enemies**

America will need global air mobility to preserve its security in a world characterized by multiplying conflicts and threats. Aggressive states, extremist organizations with regional and international influence, international criminals, natural disasters, restive populations, and other sources of interstate and intrastate violence are going to keep American military forces busy and moving into the foreseeable future. The 2014 National Defense Strategy summarized the future security environment as one characterized by “powerful global forces . . . [and] shifting centers of gravity . . . empowering smaller countries and non-state actors on the international stage . . . [and] a fundamentally globalized world . . . [in which] economic growth in Asia, aging populations, . . . instability in the Middle East and Africa, and many other



trends interact dynamically.”<sup>26</sup> Moreover, the availability of low-cost information technologies throughout the world increases the suddenness and scale at which regional conflicts can break out, particularly among urban populations that now comprise over half of the world’s humanity.<sup>27</sup> Little wonder that the chairman of the Joint Chiefs of Staff declares that “the military does not have the luxury of focusing on one challenge to the exclusion of others. It must provide a full range of military options for addressing both revisionist states and VEOs [violent extremist organizations]. Failure to do so will result in greater risk to our country and the international order.”<sup>28</sup> The American military of the future, in short, will be a military on the move—often, of necessity, by air.

America’s efforts to deal with such a multiplicity of threats will confront many state and nonstate opponents able to strike the full depth of its military capabilities. Depending on the enemy, US forces deploying into a conflict situation could face many threats, including:

- space surveillance and warfare systems,
- robust cyber intrusions and attacks,
- long-range ballistic and cruise missiles,
- aircraft launching close-in and stand-off weapons of precision accuracy,
- wide arrays of land- and sea-based tube and tactical missile artillery with ranges extending from 10–300 nautical miles (nm) and equipped with precision warheads,
- naval combatant ships firing long-range cruise missiles out to 1,000 miles,
- special operations forces,
- terrorist cells, and
- fifth columnists drawing from the large immigrant populations of the United States and many allied nations. Indeed, one of the surveillance systems plaguing air mobility forces could be the eyes of thousands of unfriendly individuals wielding encrypted cell phones.

The threats to American military capabilities go much further than commonly recognized. For example, much of the current discussion of the proliferation of enemies possessing antiaccess/area-denial (A2/AD) capabilities tends to focus on their abilities to block or hinder American access to and operations within contested regions. But a fuller appreciation of the A2/AD challenge would reveal enemies able to observe and strike air mobility forces

from the homes of their personnel all the way to their forward-most bases, engagement zones, and fighting positions. Consequently, while American military forces have always faced daunting challenges, this is the first time they have confronted a situation offering no reliable operational or logistical sanctuaries anywhere.

No one seriously engaged in American defense affairs can doubt the vital importance of developing air mobility forces able to counter these daunting combinations of threats and difficulties. The *National Military Strategy of the United States* declares that “the execution of integrated operations requires a Joint Force capable of swift and decisive force projection around the world . . . rely[ing] upon a global logistics and transportation network.” The document subsequently reaffirms the criticality of maintaining capable and relevant mobility forces, saying simply that “as the Department rebalances toward greater emphasis on full spectrum operations, maintaining superior power projection capabilities will continue to be central to the credibility of our Nation’s overall security strategy.”<sup>29</sup> In short, if the nation does not make the investments and policy adjustments needed to keep air mobility forces relevant in a more demanding and dangerous world, most US strategic, operational, tactical, and logistical concepts will lose some or even all of their relevance.

### **Air Mobility Program of Record: Capabilities and Shortfalls**

The cancers of future failures originate in the complacencies of current successes: If this premise is accepted, then air mobility planners should examine their future prospects with skeptical objectivity and in magnified detail. The recent history of the national air mobility system suggests that it is highly capable and in the hands of a community of unprecedented expertise. This community’s ability to balance the demands of numerous wars and an endless variety of other contingencies demonstrates its ability to get the most out of the complex network of air mobility operating and support forces. Still, the NAMS is aging and routinely engaged near or at its maximum capacity in a rapidly evolving and very tough world. For those reasons, this section examines features of the present air mobility modernization program that limit American military options today and that could lead to strategic and operational disasters in the future. These features include the persistent inadequacy of global airlift capacity; the lack of a capability to deliver medium-weight forces, outsize equipment, and robust cargo flows into Tier 2 and 3 airfields; and the vulnerability of the air refueling fleet.

## Modernization

Given the importance of operational flexibility in the face of an uncertain future, the ongoing recapitalization of the mobility fleet should raise long-term concerns. The two major recapitalization efforts—replacement of KC-135s with KC-46As and of older C-130s with C-130Js—are imminently necessary given the geriatric conditions of the outgoing aircraft. The KC-46 carries a little more fuel than the KC-135 under optimal conditions (212,000 pounds versus 200,000 pounds). But from shorter runways and at higher density altitudes, the newer plane can take off with as much as 30–40 percent more fuel than its predecessor.<sup>30</sup> Still, as another increment of repurposed airliners, KC-46s require basically the same Tier 1 and high-end Tier 2 runways and expansive paved parking areas required by the aircraft they are replacing. Thus KC-46s will enhance the operational flexibility of the air mobility fleet marginally, but they do not address the core problems of finding enough bases for them in many conflict situations and of protecting them from enemy detection and attack, particularly on the ground. Likewise, C-130Js enhance the overall flexibility and capacity of the existing airlift fleet marginally, but they do not address the ability of the fleet to accomplish key missions. The aircraft is 30–40 knots faster and climbs more quickly than its immediate predecessors in the 60-year-long heritage of the C-130 design, and it is easier to maintain. But its basic payload capacity and cargo deck dimensions are unchanged from earlier models. The aircraft remains limited in its ability to support the maneuver and logistics of modern ground forces and air forces operating at forward locations.<sup>31</sup> In short, as the only two major recapitalization air mobility programs currently under way, these programs bring incremental improvements in basing flexibility and capacity, but they do not represent needed upgrades in the ability of American air mobility forces to support future land and air operations.

Beyond the ongoing KC-46 and C-130J programs, AMC's plans for major recapitalization in the future are inchoate. The continued technical health of the C-17 fleet reduces the command's sense of urgency for acquiring a new C-X strategic transport. In 2013 the Headquarters Air Force Life Cycle Management Center increased the projected service life of the C-17 from 30,000 flight hours to 42,750 hours, and unofficial Boeing estimates suggest that the aircraft could safely fly past 45,000 hours. Similarly, AMC plans to rely on a modernized C-130 fleet to cover the theater airlift mission indefinitely and, accordingly, is not engaged in specific planning for a successor aircraft. Notionally, AMC anticipates acquisition of a second batch of tankers after the current program of 179 KC-46s is complete but has yet to state the specific

requirements or general design characteristics of those aircraft.<sup>32</sup> In net, then, AMC's planning for the future seems limited to conjectural examinations of technology opportunities and examinations of near-future operational requirements and capabilities.

### **Insufficient Global Airlift Capacity**

Despite the unequaled sophistication, capacity, and professionalism of American airlift forces, the impression that they are and will continue to be inadequate to some of their tasks is as inescapable as it is difficult to quantify in an unclassified document. From a qualitative perspective, the high day-to-day operating pace of airlift forces and the growing demands and threats they face provide some evidence that the country now needs more airlift capacity than it has and airlift aircraft better able to meet emerging challenges. Since the most recent air mobility requirements and capabilities studies remain classified, it is impossible to present here an authoritative, quantitative case that capabilities remain short of needs. The record of earlier planning efforts, however, suggests qualitatively that such must be the case.

The 1981 *Congressionally Mandated Mobility Study (CMMS)* is the logical place to begin an assessment of the record of air mobility planning shortfalls. The *CMMS* ushered in an era of increasingly sophisticated and detailed examinations of air mobility requirements. It was the first major study that examined air mobility from a global perspective and as an element within the whole tapestry of American air, sea, and land transportation capabilities and alternatives. In a manner that became typical of subsequent studies, the ultimate force structure recommendations of the *CMMS* were as much about fiscal constraints as actual requirements. After assessing complex mobility scenarios involving large force deployments into the Arabian Gulf region, Europe, and Korea, defense planners suggested a "fiscally responsible" strategic airlift capacity target of 66 million ton-miles per day, even though the scenarios assessed called for as much as 124 MTMD. The study implied that the potential offsets for these shortfalls would be the blood of American Soldiers and higher risk of failure, asserting at one point that "failure to meet the schedule for the approximate four divisions required in the first 25 days to face [a Soviet invasion of Iraq] could require a 15-division force to drive these enemy forces out at a later time."<sup>33</sup>

Events during the First Gulf War (1990–91) proved the point. Although the commercial, active, and ARC components had reached a notional combined capacity of 49 MTMD, they only achieved an average productivity of 13.6 MTMD.<sup>34</sup> This fractional performance was a consequence of unforeseeable

breakdowns in shipper coordination, delayed arrivals of cargo shipments at aerial ports of debarkations, inefficient loading of individual aircraft, and so on.<sup>35</sup> Ultimately, global air mobility forces delivered about 600,000 troops and 540,000 tons of cargo into the Southwest Asia area of operations over a period of six months.<sup>36</sup> This did not compare well to the 200,000 tons in 15 days called for in the congressional study's Persian Gulf scenario.<sup>37</sup>

Later Defense Department air mobility plans continued the CMMS pattern of paring down air mobility force structure goals to fit contemporary notions of what senior leaders believed was affordable. The next major Defense Department study of airlift reduced the capacity target to 54.5 MTMD, which closely matched the capabilities of the fleet then in existence.<sup>38</sup> Similarly, the current mobility planning guide, the *Mobility Capabilities and Requirements Study 2016*, aims at 56.4 MTMD.<sup>39</sup> Of significance to the adequacy and flexibility of these planning bogies, the Civil Reserve Air Fleet's planned contribution increased 149 percent between 1991 and 2016, from 18 to 26.8 MTMD, while the military component share dropped from 31.7 to 29.7 MTMD. In a future marked by continually high demands and intensifying threats, these plans are increasing reliance on the most risk averse and legally restricted—albeit also least expensive—component. Perhaps the wisdom to be gained from this is an understanding that official air mobility force structure bogies reflect budgetary realities as much as or more than they do military requirements.

### **No Outsize STOL/RF Theater Airlift Capabilities**

Another troubling shortfall in the air mobility system is its limited ability to sustain high capacity force and sustainment flows into short and undeveloped airfields and landing zones in the face of significant enemy A2/AD threats. The absence of outsize-cargo-capable aircraft possessing short takeoff and landing rough field capability is a characteristic of the current mobility fleet and is not obviously being addressed in any concrete plans.<sup>40</sup> As a consequence, the present and likely future air mobility fleet does not have the flexibility and capacity to support established ground force maneuver concepts, and its ability to support combat air units based at Tier 2 and 3 airfields and even at damaged Tier 1 airfields will be limited.

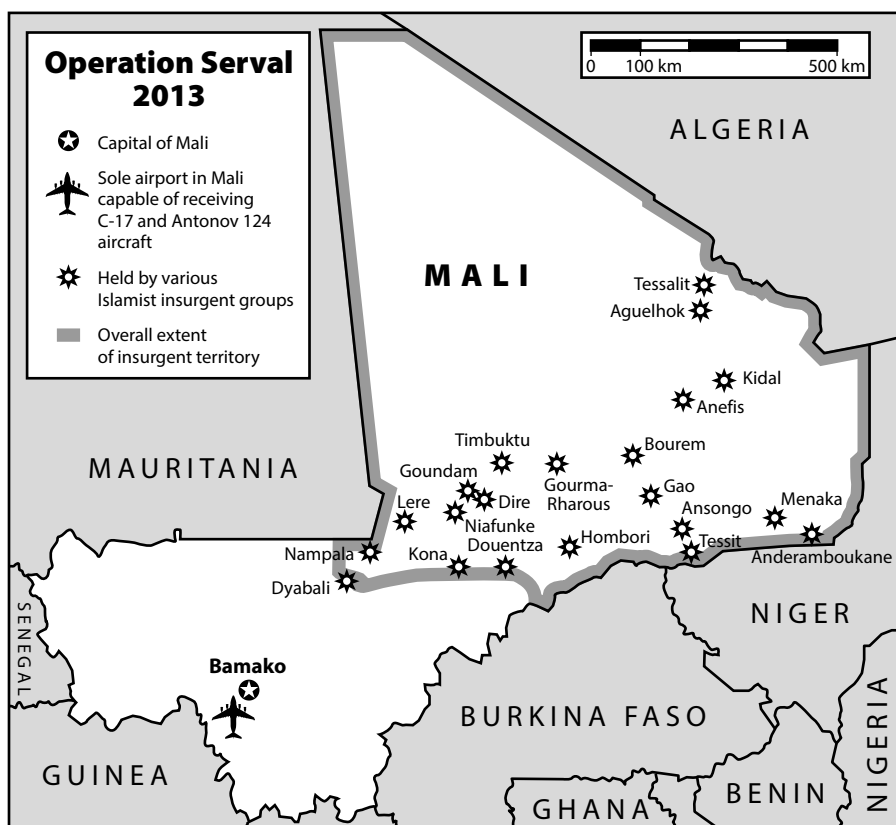
The current combination of C-17s and C-130s in the airlift fleet epitomizes the outsized cargo and STOL/RF gaps. C-130s can operate into short and rough airfields and FARPs, but their payload and cargo-dimension limitations restrict their ability to provide maneuver and sustainment support. C-17s can carry outsize loads and more tonnage, but they can't operate repetitively into

the austere locations most likely to be available in forward combat zones. In a South China Sea conflict scenario, for example, C-130s flying unrefueled, 2,800 nm, round-trip missions from Anderson AFB on Guam to the Philippine island of Luzon would deliver a maximum of six tons of cargo per mission, compared to C-17s delivering 60 tons.<sup>41</sup> But the C-17s are less likely to find a place to land than the C-130s. Under standard sea-level atmospheric conditions of temperature and atmospheric pressure, C-130s can take off in 1,700–3,200 feet depending on how much fuel and cargo they were carrying.<sup>42</sup> A C-17 would require 2,500–7,000 feet under those conditions.<sup>43</sup> Also important to the flexibility of the existing fleet, C-130s can make as many as 1,500 landings and takeoffs from unpaved runways and open fields with California bearing ratios of 10 before rendering those fields unusable.<sup>44</sup> With their much greater weights and higher landing speeds, C-17s will rut, gouge, and otherwise render the same airstrips unusable in just 30 landings and takeoffs.<sup>45</sup> C-130s or aircraft of similar airfield requirements also could utilize multilane highway strips and dry farm fields, while C-17s could not.

The range, payload, and cargo dimension limitations embedded in the C-17/C-130 fleet present the Army with several challenges to its future effectiveness. They moot the mounted vertical maneuver concept. In more traditional maneuvers, land force commanders will face a Hobson's choice: (1) not making air movements at all, or (2) accepting tactically dangerous divisions of their forces between light elements debarking from C-130s at their PON/Es—without vital mobile protected firepower assets—and heavy elements arriving at more distant airfields and making long and hazardous road marches to catch up. That compromise might be difficult in light of the scarcity of C-17- and C-130-capable airfields in many regions of the world. As discussed earlier, there may be only about 16 airports in sub-Saharan Africa capable of acting as C-17 hubs. Plus, the C-130s operating out of those hubs may not find C-130 capable airfields near ground-force PON/Es and, if they can, may not be able to deliver critical mobility and firepower assets. One recent study of airlift operations in Africa found that about half of the 158 airfields surveyed in the region are “impractical for operating a C-130 or larger aircraft” and that the percentage of the 3,300 airfields identified in the region able to handle heavy aircraft was unknown. In one specific case, the study found that a portion of a Tier 2 runway selected for an exercise was too weak for safe C-130 operations.<sup>46</sup> Little wonder, then, that the Army believes that fixed-wing air transports generally would deliver ground units in Africa no closer than 50 kilometers from their PON/Es.<sup>47</sup> Even when considering movements in developed regions of the world, Army planners wonder if the existing fleet has the capacity to sustain conventional operations in A2/AD environments.<sup>48</sup>

The 2013 French military intervention against Islamic insurgents in Mali demonstrated the reality of these concerns. During Operation Serval, the French had support from US C-17s and leased Antonov 124 airlift aircraft capable of delivering outsize, medium-weight armored vehicles, most importantly 25-ton VBCI infantry carriers. But with only the airport in Bamako capable of receiving those aircraft, French motorized units made road marches up to 3,000 km long to reach their objectives.<sup>49</sup> French airborne units did conduct some operations to seize key bridges and C-130-capable airfields during the advance from Bamako into the far eastern areas of Mali. However, these units did not arrive with medium armor support, and they went in only a day or so before the main force arrived to back them up. Thus the French advance was conducted as a serial roll up of Islamist resistance and proceeded at an average of 60–80 kilometers per day. As a result of this slow advance, the French never were able to cut off retreating Islamists; consequently, most of them had escaped death or capture and retained their weapons by the end of the campaign.<sup>50</sup>

Given the pedestrian pace of the campaign advance and its limited results, it is seductive to consider what French commanders would have done with the capabilities offered by the fleet of A400M transports now coming into the French air force. Capable of operating from virtually any unpaved airstrips or open-terrain landing fields available to C-130s, A400Ms can carry payloads of up to 37 tons, which would accommodate virtually any armored combat vehicle except main battle tanks and the heaviest self-propelled artillery, along with associated support vehicles and equipment. Had they been available during Operation Serval, A400Ms could have lifted any vehicle actually used in the campaign in nonstop sorties from France to anywhere in the operational zone and then flown as much as 1,000 nm further before stopping for fuel. With a fleet of such aircraft on hand, French commanders in Mali could have conducted a parallel instead of a serial land campaign. A parallel campaign would have involved the insertions of mobile, hard-hitting forces throughout the depth of the line of advance whenever tactical opportunities presented themselves. Because they included medium-weight mobile protected fire-power, the depth and frequency of such insertions would not have been restrained by the location of the main advance, at least not to the extent that they actually were. Such wide-ranging and unpredictable “heavy cavalry” operations likely would have shortened the campaign and enhanced its impact. Deep-operating mobile forces could have hit Islamist units as they scattered and chased them in hot pursuit while they were in the open. The long-term effect almost certainly would have been residual enemy units and personnel less able materially or psychologically to renew guerilla operations.



**Figure 7. Operation Serval map.** This map of the French military's operating area illustrates the distances involved.

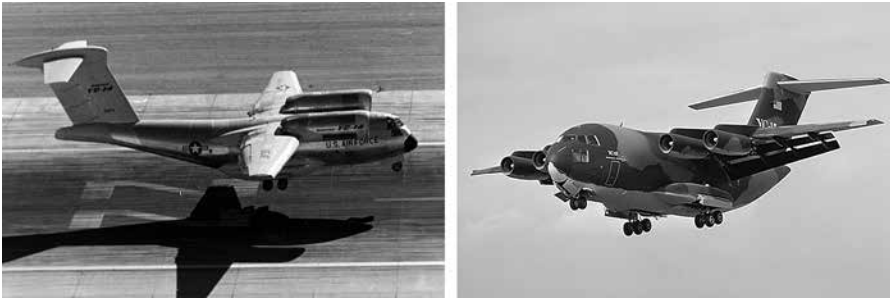
Combat air force commanders also should see the value of large, STOL/RF aircraft. Combat squadrons deploying into established air bases usually require only a few C-17 sorties to bring in their ground support echelons. But if these forces move into bases not already equipped with fuel storage and distribution systems, appropriately stocked munitions bunkers, billeting facilities, fire trucks, and so on, the airlift bill increases drastically and must be paid by steady streams of air transports until surface lines of communication can be established. Normally such movements would be supported by C-5s, C-17s, and perhaps CRAF aircraft. If the runways of these airfields are short, weak, or damaged by enemy attacks, however, bringing in these big jets can be impossible or unacceptably risky. Even if airfield infrastructures are intact but threatened by enemy attacks, air commanders likely will cringe at the sight of



transports loaded with many tons of munitions or fuels taxiing in proximity to their parked combat aircraft and then parking themselves at spots long before identified and pretargeted by enemy weaponeers. In such circumstances, air commanders likely would welcome the availability of high-capacity transport aircraft able to operate on the unpaved margins of their airfields or perhaps at airstrips or open-field landing zones separated from the primary runways, parking ramps, and other vital facilities of their main bases.

Air commanders anticipating disaggregated operations from networks of austere airfields or FARPs should also be concerned about the present composition of the air mobility fleet. In regions such as the western Pacific, the Middle East, Africa, and eastern Europe, airfields that can accommodate conventional fighters and large transport aircraft are scarce. In a South China Sea conflict, for example, the entire island of Luzon has only five airfields with runways at least 7,000 feet long and parking ramps to handle a dozen fighters and one or two C-17s.<sup>51</sup> Even Marines employing short takeoff and vertical-landing (STOVL) AV-8B or F-35B aircraft at highway or smaller airfield-based FARPs will face challenges in obtaining supplies and support from the existing Air Force transport fleet. In many such cases, reliance on C-17s to deliver support to these FARPs will oblige Marines to debark substantial rotary-wing aircraft or truck complements to move supplies from main airports to the FARPs. C-130s could potentially deliver supplies and most required support vehicles to STOVL FARPs, but their small payloads over strategic distances would limit the scale of combat operations they could support.<sup>52</sup>

For decades, the US defense community has recognized the need for an aircraft able to bridge the operational gap between large airfield-restricted aircraft and smaller, more airfield-agile aircraft. The YC-14 and YC-15 aircraft developed in the mid-1970s were efforts to bridge this gap. Both of these aircraft were capable of delivering nearly twice the payloads of C-130s into shorter and softer airfields. The Air Force expected the aircraft selected for production to carry 30-ton loads into 3,500-foot and 20 tons into 2,000-foot airstrips. The Army endorsed the advanced medium STOL (AMST) transport for its ability to “bridge the gap of thirty years of troop maldeployment . . . [and] forced centralization of depots . . . by flying supplies and equipment to sites within the forward combat zone” and as a way to move heavy combat units within theaters of operation “when the tide of battle . . . may demand.”<sup>53</sup> The Defense Department, however, cancelled the AMST program in 1979 to free funds to develop a C-X aircraft, which became the C-17, better able to transport reinforcements from the United States into Europe should the Warsaw Pact launch a surprise attack.<sup>54</sup>



**Figure 8. YC-14 (left) and YC-15.** Though jet powered, both of these outsize transports had straight wings and lift augmentation devices to give them STOL capabilities.

After cancellation of the AMST program, over three decades of theater airlift modernization studies consistently called for development of an outsized theater airlifter. One milestone study was the Army-Air Force 1984 *Qualitative Intratheater Airlift Requirements Study*, which called for acquisition of an aircraft “capable of delivering outsized cargo to small, austere airfields . . . 3,000 feet long.”<sup>55</sup> Most recently, the AMC’s 2013 *Joint Future Theater Lift Study* examined options to satisfy requirements for an aircraft “capable of (1) moving medium-weight armored vehicles and personnel to strategic, operationally, and tactically significant depths and (2) supporting maneuver in close proximity to objectives and sustainment of distributed forces in complex, austere, unimproved/unprepared landing areas to point of need/point of effect. The platform must be able to carry and/or airdrop required cargo loads into and out of complex, austere, unimproved/unprepared landing areas.”<sup>56</sup> Based on the requirement for outsized precision deliveries as close to PON/Es as possible, the study assessed the program risk of a \$128 billion program to develop, acquire, and sustain for 30 years a fleet of 96 VTOL tilt-rotor aircraft as low and a \$36 billion program involving 49 conventional takeoff and landing (CTOL) aircraft as high.<sup>57</sup> Thus the real issue in the study was not the need for an outsize capability but the trade-off between cost and the degree to which the Air Force could attain the precision delivery goal.

Inescapably, then, the challenge to acquire a new outsize-capable theater airlifter is about money and, therefore, politics. For the foreseeable future, virtually any US defense leader would hesitate to start an effort to find funding within already overstressed defense budgets for a \$128 billion VTOL airlifter or even for a \$36 billion CTOL aircraft. Any such effort would entail difficult trade-off decisions with other programs and would run headlong into the powerful military, industrial, and political constituencies of those

other programs. The challenge would be exacerbated by the fact that the only outsized STOL/RF airlifter likely to be available for the next 30 years or so will be a foreign design.

There is no glossing over the fact that the outsized STOL transport choice before US defense planners is between the A400M and nothing for a long time to come. The only other outsize theater airlifters available or in development either come from countries that would be unacceptable as American military aircraft suppliers (the Russian Antonov AN-70 or Chinese Xian Y-20), do not possess the necessary STOL and rough field capabilities (the Kawasaki C-2), or are too small (the Embraer C-390 and Lockheed C-130). Moreover, experience with the C-17 program suggests that an effort to build a new theater airlifter would not put even the small force of 49 aircraft called for in the *Joint Future Theater Lift Study* on the ramp until well after the professional careers of everyone reading this paper have ended. The C-17 program took 20 years from authorization to get 49 aircraft into squadron service (1979–99) and took another 14 years to complete production for the Air Force in 2013. Given that the Air Force likely will not begin production of a new theater airlifter until after it completes production of a new C-X aircraft to replace the C-5 and C-17, the earliest that an operationally useful force of next-generation theater airlifters could be available would be around the latter 2040s. So the choice before the Defense Department regarding theater airlift modernization is to either buy a niche force of A400Ms now or live without an outsize theater airlift capability for decades to come.



**Figure 9. A400M on grass and dragging F-18s.** Theater tanker/transport, such as these A400s, offer the flexibility of Tier 3 airstrip operations and air refueling. (Photographs courtesy of Airbus)

### **Increasing Vulnerability of the Air Refueling Fleet**

Air commanders confronting opponents in possession of strong air forces and long-range weaponry have several reasons to worry about the vulnerabil-

ities of their air refueling fleets. Most important, tanker aircraft hold central importance to virtually all American air warfare concepts and capabilities. Our potential opponents know that and undoubtedly will seek ways to destroy tanker forces in any major conflict. Also of importance, air refueling aircraft are large aircraft, easier than other air elements to detect in the air and on the ground, and vulnerable to a host of long-range weaponry. In the air, they could face radar-guided missiles fired from as far as 200 nm away and flying at Mach 3 or faster and large, all-capabilities “gorilla packs” of enemy aircraft with ranges of 400 nm or more that are capable of chasing fleeing tankers at supersonic speeds. On the ground, tanker parking areas at most airfields likely will be pretargeted by sophisticated enemies. They’ll likely be subject to both direct and shot-in-the-blind attacks by air-to-ground missiles, bombs also released from a few to hundreds of miles away, and ground-to-ground cruise or ballistic missiles ranging out to 1,000 nm or more. All of these weapons are capable of precision, terminal guidance to within a few meters of their aim points.

In any robust combination, these vulnerabilities will force air commanders to choose between basing their tankers forward to maximize their effectiveness or rearward to ensure their survival, not a happy choice to make in high-intensity air wars. In a conflict centered on the South China Sea, rearward would mean basing tankers at least out to the so-called second island chain, which would include the Marianas, Guam, Micronesia, and Palau. These islands presently are beyond the capabilities of potential enemies on the Asian mainland to launch sustained and concentrated air and missile strikes. Safe basing of tankers supporting operations over eastern Europe would involve locations in Britain, southern France, and Spain. Even then, all of these locations would be at risk from standoff air attacks and cruise missiles fired from warships and submarines. As an example of the operational impact of such rearward basing, KC-46s operating from Anderson AFB, Guam, would burn 65,000 pounds of their 212,000-pound fuel capacity just getting to and from a refueling orbit over the west coast of central Luzon.

Tanker vulnerabilities also will force embattled air commanders to make hard choices about how many of them to bring into their theaters. Along the second island chain, for example, only a handful of air bases and civil air fields can support operations by fully loaded tankers, and most of them have limited parking areas. Even in a developed region such as western Europe, tanker basing options can be limited. As exemplified by the experience of *Odyssey Dawn*, the NATO air campaign over Libya in 2011, tanker basing options were sharply restricted by the refusal of civil authorities to open commercial airports to air refueling operations and by the competing claims of air combat

units for scarce parking space at available military fields.<sup>58</sup> Even if parking is available at major airfields, air commanders will have to think twice about jamming a lot of tankers into them and making them vulnerable, lucrative targets for enemy attack. In net, then, the vulnerabilities of the existing Air Force tanker fleet present air commanders with a difficult choice calculus, the outcome of which would shape the combat power, resiliency, and operational flexibility of their air campaigns.

The obvious hazards presented by the vulnerabilities of the tanker fleet have engendered numerous official and unofficial studies and proposals for mitigating them. Much of the official literature, understandably, is classified. But a blog contribution by two knowledgeable insiders articulates the key concerns of the potentially devastating impact that even a low tanker attrition rate could have on combat air operations. Greg Knepper and Peter W. Singer suggest mitigation strategies that include installing better defense capabilities in new KC-46As and developing fighter escort and barrier defense tactics to protect them.<sup>59</sup> Other studies have explored the use of agile basing strategies to improve the resilience and efficiency of air refueling forces based inside enemy weapons engagement zones. One study suggested integrating sea bases into the support of disaggregated air refueling forces, shifting rapidly between austere bases and parking locations on those bases.<sup>60</sup> A later study concluded that while hardening or dispersing their bases offered air refueling forces limited advantages in their resilience, agile basing was the only methodology likely to make them survivable in sustained operations against strong enemies. When conducted by “theater” tankers able to operate from marginal airfields and highway strips, this latter study concluded that agile basing also would greatly improve the efficiency and scale of air refueling operations. Perhaps most importantly, the freedom to base tankers well forward would enhance their ability to support surges in offensive and defensive combat operations and to respond to the unpredictable ebb and flow of military events.<sup>61</sup>

The study on tanker basing strategies also suggested that the practical choice for theater tankers able to operate from austere airfields presently was the same as for theater airlift, one between the KC-130J and the A400M. All other available tanker aircraft fall out of reasonable consideration either because they are airliner-derived designs with limited airfield agility or because they offer only marginal or virtually no advantages over aircraft already in or coming into the core air refueling fleet.<sup>62</sup> The KC-130J and the A400M are classic theater airlifters designed for operations into a wide range of airfields. Their ability to operate on unpaved surfaces can also facilitate their dispersal around forward airfields. Equipped with rear cargo doors, which to date have prevented the installation of refueling booms, both aircraft are only capable of

probe-and-drogue type air refueling operations. Consequently, they would be limited to refueling probe-equipped Marine Corps, Navy, and most allied combat aircraft. This is hardly the handicap it might at first seem, since US air component commanders are obliged to provide common-user support to Marine Corps and Navy aircraft and frequently are called upon to render similar help to allied aircraft engaged in combined operations. Further, having an airfield-agile force of drogue-equipped tankers available to meet the bulk of their common-user obligations would allow joint force air component commanders to concentrate their longer-range (and possibly limited numbers of) refueling boom-equipped tankers to service Air Force aircraft. Additionally, as Marine Corps airmen have known for decades, a force of KC-130, A400M, or similar aircraft would offer useful airlift options for supporting ground maneuvers or forward air bases and airfields.



**Figure 10. KC-130 with two F-35B Lightning II Joint Strike Fighters.** This Marine Corps KC-130 also is capable of operating from Tier 3 airstrips and conducting air refueling operations.

## Opportunities

This paper has articulated some of the salient contextual elements of airlift policy making and identified troubling shortfalls in the capabilities of the US national air mobility system to meet future demands. Important contextual elements identified include the emergence of an increasingly complex and dangerous world for air mobility operations and enduring considerations of structure, mission, technology, money, and politics. Shortfalls identified are inadequate long-range lift, the absence of outsize theater lift, and tanker vulnerabilities. These shortfalls have existed in the fleet for decades, but the

emerging context of air mobility increases their importance and potentially negative consequences for national security. Accordingly, this paper now turns to considering some options for mitigating these shortfalls without ignoring the policy constraints of structure, mission, technology, money, and politics—at least not excessively.

The first order of business for the airlift community is to begin setting the stage for the next air mobility requirements study (MRS). Based on discussions with active and recently retired air mobility leaders and analysts, this paper concludes that the Department of Defense is not likely to initiate the next such study until mid to late 2017 or even into 2018. That date will allow the next administration to articulate the strategic priorities and military guidance needed to provide a foundation and justification for a requirements study. Meanwhile, the DOD and its combatant and service chains of command should begin settling a number of background issues that will shape the next MRS, regardless of when it is initiated or its strategic foundations. A short list of these outstanding issues includes:

- articulating the low-risk airlift and air refueling requirements of each combatant command for its most likely worst-case contingency,
- articulating lesser-case requirements that might call for specialized airlift and air refueling support or aircraft not included in the baseline worst-case contingency,
- settling the mounted vertical maneuver issue, at least for the midterm. Potentially, MVM is the long-pole requirement for theater airlift investment. Consequently, the Defense Department needs to issue a *yes*, *no*, *defer indefinitely*, or *pursue a less aggressive variation* decision as soon as possible to clear the air for theater airlift planners,<sup>63</sup> and
- developing realistic planning factors for operations in the face of robust A2/AD threats. These planning factors likely will include disaggregation tactics, unit reorganizations, logistical requirements, fleet capabilities requirements and gaps, and minimal expected rates of attrition.

This stage-setting effort also should consider the methodology of the next requirements study. The legacy pattern of such studies since the 1981 *Congressionally Mandated Mobility Study* has been focused on major force movements between *undegraded* Tier 1 and 2 airfield networks. Essentially, air mobility requirements studies to this point have been incrementally refined variations of the Reinforcement of Germany exercises of the latter half of the Cold War, meaning that they focused on the flow of massive forces out to conflict areas and gave little or no attention to return flows, let alone onward

deployments to engage in other crises. But now, given the shrinkage of US forces and the proliferation of threats they face, large-scale theater-to-theater movements have become an unavoidable planning consideration. The airlift and general mobility communities, therefore, should think deeply about how to integrate such movements into the next MRS.

In addition to enhancing the conceptual foundations and methodology of the next MRS, air mobility planners should begin developing an integrated roadmap for recapitalizing the airlift and tanker fleets. Against a budget-driven constraint of spending as little and late as possible, this roadmap should begin by considering near-term modernization needs and opportunities that also offer offsets from other programs. Based on this present reading, the most pressing air mobility issues are the absence of an outsize theater airlift aircraft in the fleet and the vulnerability of the tanker fleet in A2/AD environments. These concerns represent immediate risks to the Army's ability to conduct parallel operations in depth and the Air Force's capacity to fight major wars in many global regions. The realistic aircraft options for addressing these issues—C/KC-130Js, A400Ms, or nothing—should be assessed for their ability to mitigate these challenges and the offsets they could enable, such as reductions in other acquisition or service-life extension programs and early retirements of other types of aircraft.

In contrast, the far-term issues identified in this paper (modernizing and expanding global and theater airlift capabilities) require only thought now and little investment. Current acquisition programs for systems like the F-35, KC-46, and B-21 will dominate the Air Force acquisition budget until the early 2030s. Consequently, the authoritative air mobility planners interviewed for this paper agreed that a new global airlifter likely will not enter production until the mid-2030s or later and a new theater airlifter not until as much as a decade after that. These distant dates and the normal pattern of aircraft development programs imply that the air mobility community has perhaps a decade to ponder the configuration of the global airlift aircraft, and maybe 15 years to think about the next-generation theater airlifter, before the Air Force must issue requests for proposals and start spending real money on them.

Before closing, the data in this paper support some broad suggestions for addressing these challenges and shortfalls. Given the operational risks involved and the possibility that offset opportunities might be lost to delay, the air mobility community should pursue the outsize theater airlift and tanker vulnerability issues as matters of high priority. This pursuit should begin with open and objective analysis of the options, unfettered by political considerations. Hopefully, the bottom line of this analysis would boil down to the net costs (essentially, outlays minus offsets) of satisfying requirements and, in the



case of tanker aircraft, perhaps their cost per pound of fuel delivered in relevant combat scenarios.

As a final thought, it is reasonable to suggest that the global and theater airlift missions ultimately will be filled by two different aircraft. Barring miracles, future advances in propulsion and airframe designs may make for more elegant solutions to these missions, but the necessity of trading off airfield flexibility and aerodynamic performance likely will remain and thus compel designers to optimize designs for each mission. Engineers will design the next-generation global airlifter to be as capacious as possible and still fit into a useful array of Tier 1 and 2 airfields. They will, in turn, design the next theater airlifter to interface with the cargo capacities and dimensions of the global fleet, fly some definition of strategic distance, and then land at Tier 3 airstrips or, hopefully, even Tier 4 landing spots. The decades-long process of conceptualizing, advocating, designing, acquiring, and learning how to operate such a fleet will be grist for thousands of military careers in the future.

## Next Steps

This paper closes by suggesting the next two steps in the long journey to the future air mobility fleet. First, it emphasizes the need to take action on the outsize theater airlift and tanker vulnerability issues. The justifications and required specifications are not obscured in the mists of the distant future; they are already known. Second, AMC or higher should take steps to broaden and deepen the national discussion of air mobility theory, strategy, and requirements. *Broaden* and *deepen* imply participation in this discussion by a community of interested military, civil government, industry, academic, and other experts. Accordingly, this report suggests that the AMC individually or, preferably, in partnership with other organizations sponsor an annual or bi-annual air mobility conference. Besides bringing together useful combinations of practitioners and policy shapers, this conference should produce a report, and its outcomes should become action items for appropriate committees drawn from inside and outside the command. The goal should be to facilitate, discipline, formalize, and promulgate the nation's growing understanding of and investment in its air mobility enterprise, which is a true and unique American national treasure. Partnership candidates for this conference would include the Airlift/Tanker Association and its very useful annual convention, the Air Force Association and its conventions and outreach programs, the National Defense Transportation Association, and others. Finding these partners and taking this step will make many of the coming challenges

in the quest for relevant air mobility much easier to overcome and do so at minimum cost and operational risk.

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## Abbreviations

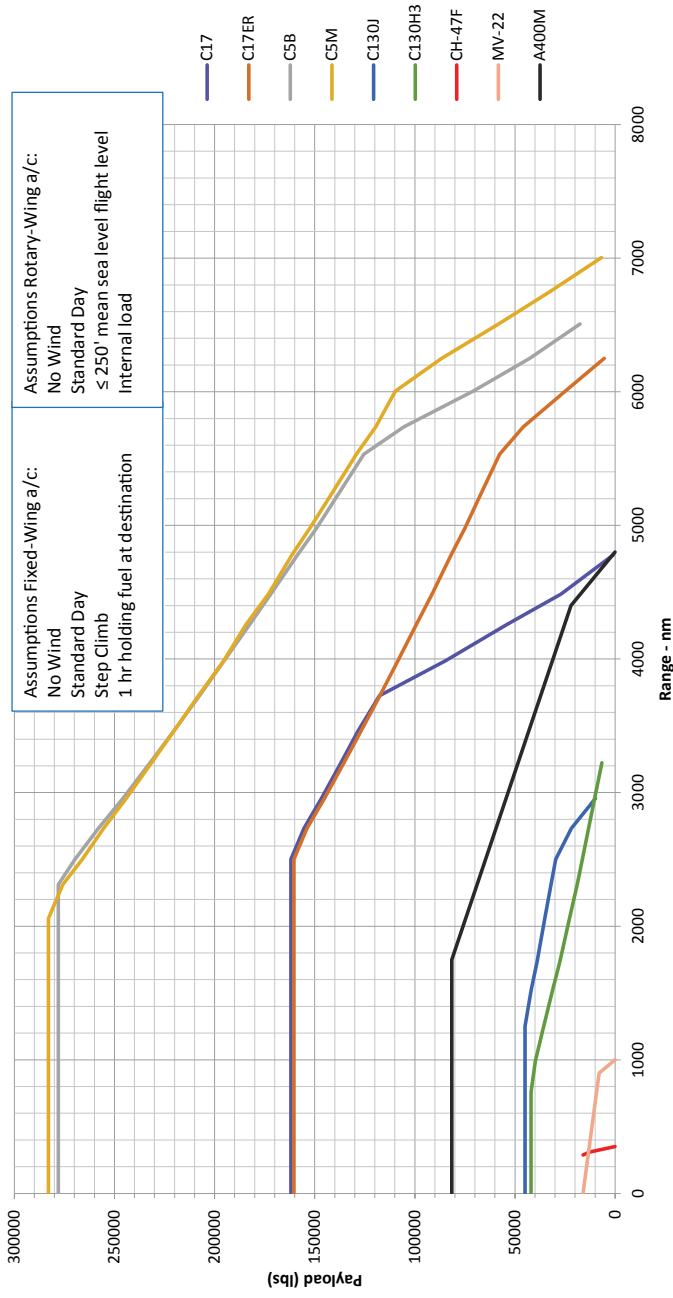
A2/AD	antiaccess/area denial
AMC	Air Mobility Command
AMST	advanced medium STOL (short takeoff and landing) transport
ARC	air reserve component
BCT	brigade combat team
CMMS	<i>Congressionally Mandated Mobility Study</i>
CRAF	Civil Reserve Air Fleet
CTOL	conventional takeoff and landing
FARP	forward arming and refueling point
MRS	mobility requirement study
MTMD	million ton-miles per day
MVM	mounted vertical maneuver
NAMS	national air mobility system
nm	nautical mile
PON/E	point of need/employment
STOL	short takeoff and landing
STOL/RF	short takeoff and landing/rough-field
STOVL	short takeoff and vertical landing
VEO	violent extremist organizations
VTOL	vertical takeoff and landing





# Appendix

## Payload-Range Comparison of Mobility Aircraft



Payload and range performances of global, theater, and battlefield (rotary-wing) transport aircraft. The author sourced these data from numerous official, manufacturer, and other sources as available in open, nonproprietary sources. (Chart by Robert C. Owen, 2016.)





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